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B29C 33/38

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(56) Documents Cited
GB 1245724 A GB 0923321 A GB 0900570 A
GB 0738403 A EP 0117985 A2

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UK CL (Edition P) B5A AA1 AA2 AA3 AB14 AM5X ANX AT14E AT14G
INT CL[6] B29C 33/38 39/26 41/38 43/36 45/26
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(54) Process for the manufacture of a mould tool

(57) Mould tooling is manufactured by a process comprising (a) forming a skin layer 12 on the surface of a master pattern 11; (b) depositing a wax calibration layer 13 over the skin layer; (c) depositing a bolster layer 14 of heat insulating material over the calibration layer; (d) shrouding the exposed face of the bolster layer with a frame 15 and filling the thus formed plenum with aggregate 16 providing thermal insulation between the bolster layer and the bolster frame; (e) separating the pattern with the attached skin layer from the bolster assembly, removing the calibration layer 13 from the exposed surface of the bolster layer, applying mould release means to that surface and relocating the pattern and skin layer on the bolster assembly; (f) introducing shim-forming plastics material into the space between the skin layer and the bolster surface; (g) separating the pattern from the rest of the assembly and the skin layer and shim from the bolster assembly; (h) removing the release means from the bolster surface and (i) locating the skin on the shim in the bolster to provide the tool.

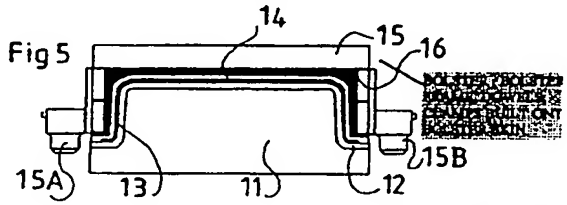

Fig 5

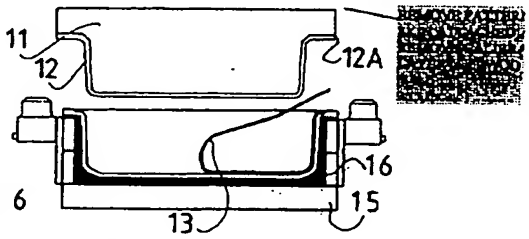

Fig 6

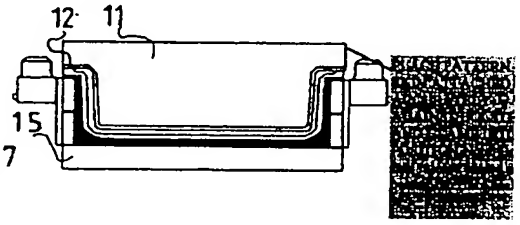

Fig 7

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.
The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995
This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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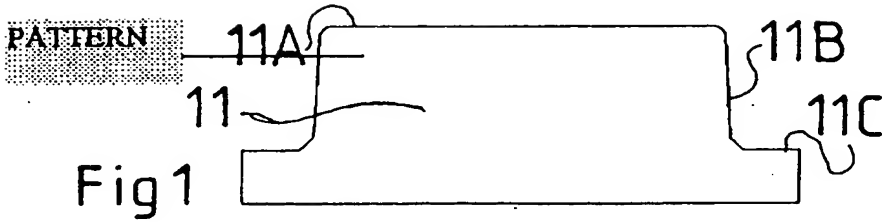


Fig 1

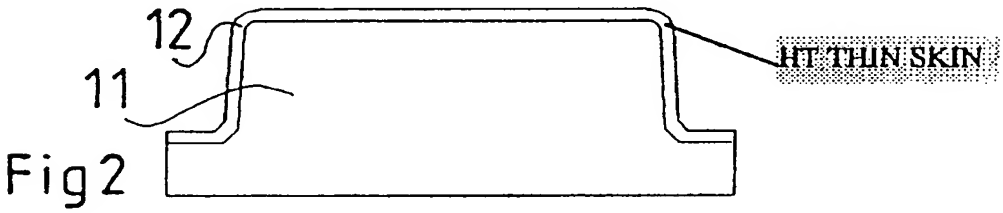


Fig 2

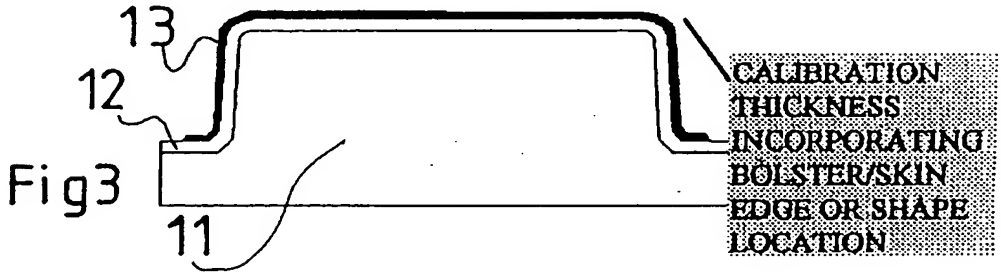


Fig 3

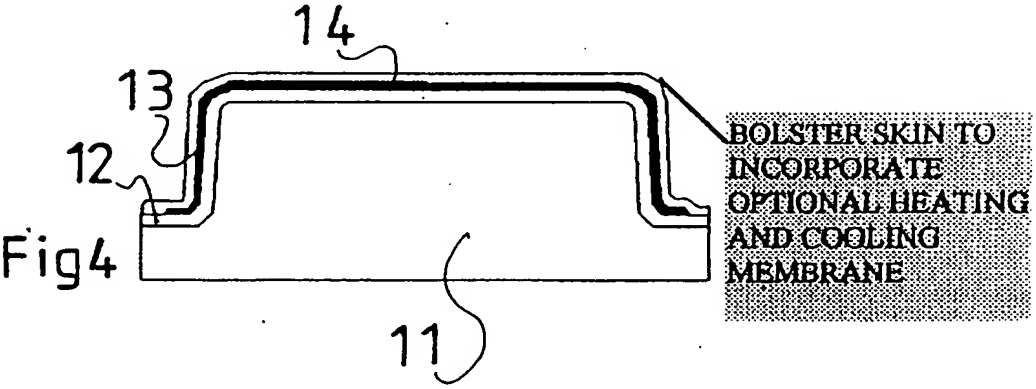


Fig 4

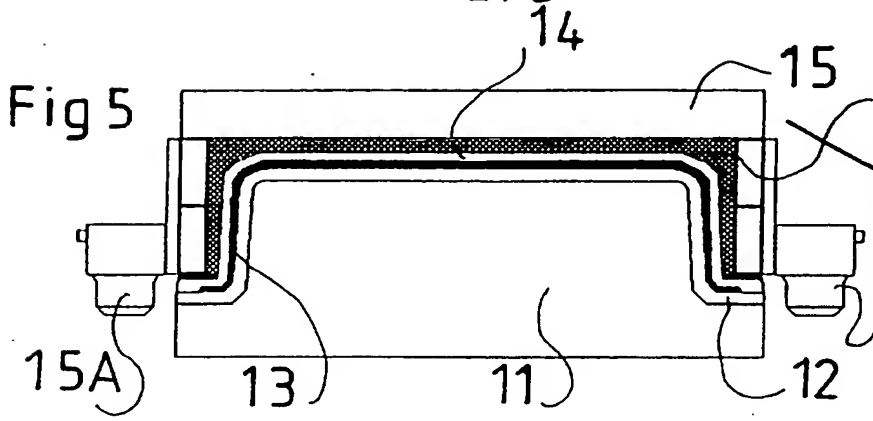


Fig 5

BOLSTER, BOLSTER FRAME, DOWELS, CLAMPS BUILT ONT BOLSTER SKIN

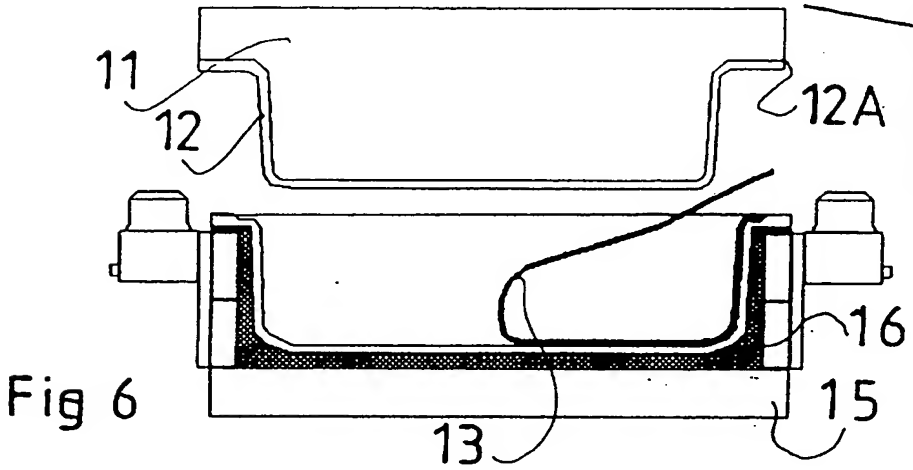


Fig 6

REMOVE PATTERI SKIN ATTACHED REMOVE CALIBRA LAYER (e.g. WAX)

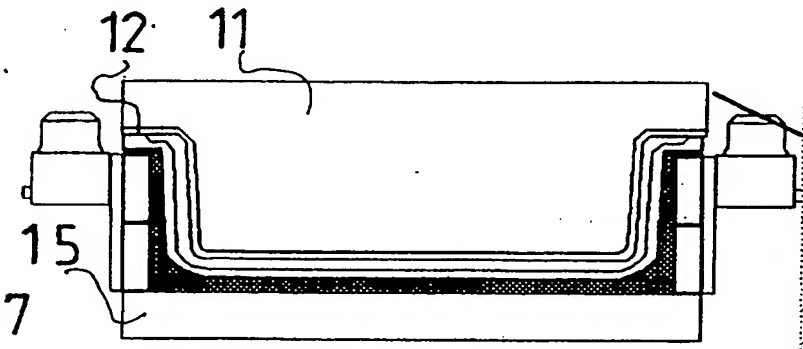
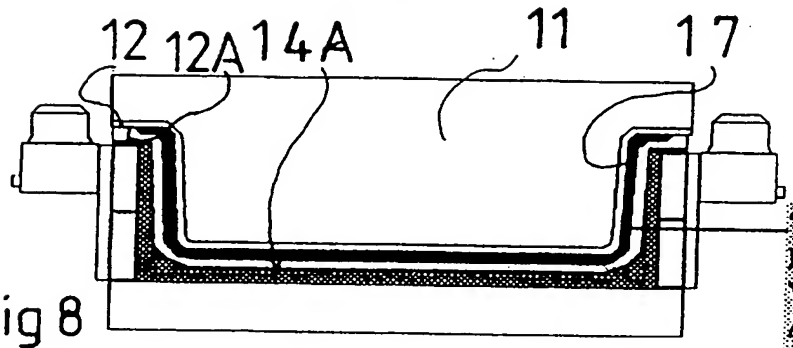


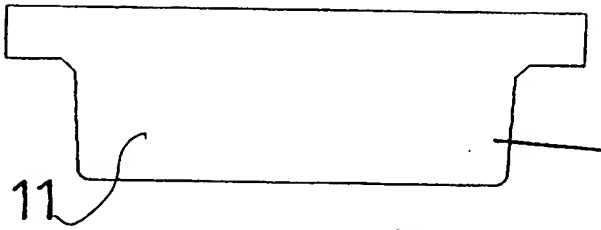
Fig 7

PLACE PATTERN SKIN ATTACHED ACCURATELY AGAINST BOLSTE AND CLAMP INTO POSITION Note: Be face release coated a bolster interface seal



"POT" SKIN AGAINST RELEASED BOLSTER WHILST BOTH HELD IN ACCURATE REGISTRATION

Fig 8



REMOVE POTTED TAILORED SKIN FROM PATTERN

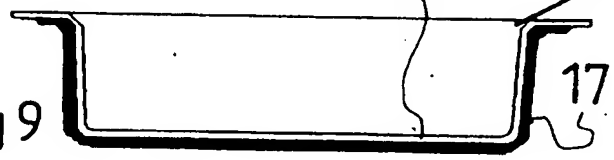
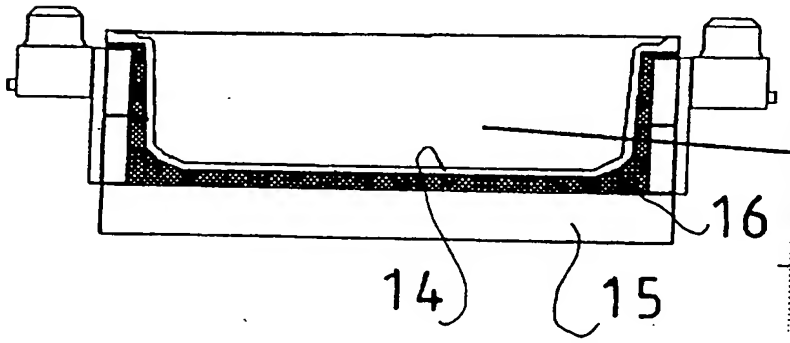


Fig 9



FIXED SIZE BOLSTER TO ACCEPT AND RUN MULTIPLE TAILORED SKINS

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TOOLING

This invention relates to tooling. It is particularly concerned with the manufacture of moulding tools.

It is known to manufacture moulding tools in the form of composite moulds based on low mass heated or unheated high temperature composite skins with integral cores. The skins and cores are supported by way of shim profiled and suitably shaped steel frame bolsters.

A composite mould can make use of a metal faced mould. The metal can be deposited as a skin by metal spraying, sheet forming, casting or machining. By whatever means are used to provide a skin the metal thickness is kept to a minimum and is cradled in a well supported elastomeric material including an embedded heater. It is supported as a skin adapted for high temperature operation and steel support frames to provide for readily matchable mould sets.

As originally conceived solid bonding of the skin to the supporting frame reduced, if it did not actually prevent, allowance for movement between skin and frame to provide for a degree of relative movement between shin and frame arising from differential expansion due to different coefficients of thermal expansion between frame and skin.

According to one aspect of the present invention there is provided a process for the manufacture of tooling comprising the use of a thin skin mould supported in a bolster by way of an elastomeric shim over its entire undersurface which is in turn supported on an in-fill in the bolster wherein the thin skin is of at least one of the following:
vacuum formed thermoplastic sheet;
metal sheet however formed;
cast metal skin;
ceramic skin however formed;
silicone or similar elastomeric matrix skin however formed;
thermoset reinforced or un-reinforced skin however formed.

The skin can be of composite construction (that is to say of two or more layers) formed to receive the elastomeric shim.

An exemplary embodiment of the invention will now be described with reference to the accompanying drawings of a skin tooling process of which each figure is a section of a during a working step in the process. The steps proceed in sequence and chronological order.

Figure 1 show a prepared master pattern 11 for the manufacture of a bowl shaped object with a bowl region 11A, sides 11B and rim 11C.

Figure 2 shows the addition of a high temperature heat resistant thin skin 12 to the master pattern 11 in the form of a lamination to a thickness of 2 - 5 mm. In this case the skin is of thermoset material but, as will be touched on later, a wide variety of skin materials can be used typically depending on what product is to be moulded.

Figure 3 shows a calibration layer 13 (typically of wax) of some 2 - 3 mm thickness

Figure 4 shows a bolster skin 14 incorporating a heating system (in this case an electric mesh heater). For a particular application this layer 14 can also include a cooling system.

Figure 5 shows a bolster frame 15 is the form of a box placed over encompassing the master pattern 11 along with skin 12, layer 13 and bolster skin 14.. With a more elaborate pattern or one with double curvature the frame 15 can be profiled in form to reduce in-fill volume. The bolster frame 15 includes dowels and clamp points 15A, 15B providing for accurate alignment of this portion of tooling with a complementary component to make up an accurately alignable mould set.

The bolster frame 15 is shuttered and filled with low cost filler aggregate 16. The in-fill has a high heat insulation value to maintain lower thermal mass. In this case low cost blown clay is used but other materials can be used such as glass balloons in a 'dry' matrix mix including air as further insulant.

Figure 6 shows the completed assembly inverted and with the pattern 11 removed together with skin 12 attached temporarily to the pattern around its periphery 12A. The calibration layer 13 is then removed.

Figure 7 shows the pattern 11 with skin 12 attached by way of its periphery 12A to the pattern 11 having had a release agent deposited on inner side 14A of bolster skin 14. The pattern 11 with skin 12 is then replaced in the bolster frame 15. The frame 15 is clamped to hold the frame 15 in accurate registration with pattern 11.

Figure 8 shows the stage in the process where resin has been injected into the gap between the pattern 11 and the inner side 14A of the bolster skin 14 to create a bedding shim 17 between the released film bolster surface 14 and the rear 12A of the mould face skin 12.

Figure 9 shows the dis-assemby of the thrree main compontnes from one another in their final form. Pattern 11 is shown lifted clear with no attachments. Tailored skin 12 with its adhering bedding shim 17 is shown lifted clear of frame 15 with its bolster skin 12. The skin 12/shim 17 combination can be stored in a suitable support or restored to bolster frame 15 for use in production. Once the bedding shim 17 has cured it adheres to the skin 12 and the profiled bolster and frame 15 is released from the pattern 11 (Figure 9) to enable the skin with its adhering bedding shim 17 to be removed as a unit as shown in Figure 9.

In other embodiments the skin and bedding shim can be separated by one or more intermediate layers to provide a composite construction made up of one or more intermediate on which the skin and the bedding shim are mounted to serve as the outer faces.

The thin skin and its bedding shim are readily moved as a unit from the bolster and then be returned to it while providing for the ready and accurate re-alingment of the skin within the bolster.

The bolster 14 van be combined with another bolster equipped by measn of a similar tool so as to provide matching closed mould set.

A wide range of variants based on the above basic process are possible under the present invention.

1 During production use the edges of the skin 12 can be sealed to the edge of bolster 14 to provide for a vacuum lock to hold the skin to the matching bolster face. It is likely to be necessary for an upper mould of the thin skinned type to be positively retained in its bolster least it should fall out when the upper bolster is raised. This can be by a vacuum lock or by a material such as Velcro (RTM) mounted in recsses in the bolster to insure that the material does not cause local distortion of the thin skin.

2 When creating similar tooling skin from matching mould half the vacuum lock referred to in 1 above can be used to ensure that any slight distortion in a tailored skimmed face skin is not replicated in the second mould half skin.

3 The use of dry packed aggregate to in-fill the bolster provides for a much higher degree of thermal insulation to be applied to a mould face than has be possible heretofore. This renders the effect of operating any heating element net incorporated in for example layer 14 to be increased in efficiency. In addition a labyrinthine path can be created in the bolster directly behind the bolster face to provide for relatively simple and effective air cooling to be used rather than liquid cooling techniques (though liquid cooling may be appropriate and can be incorporated in a thin skin mould procees).

4 The locking shim 17 requires to be of low, is not zero, shrinkage so as not to distort the working skin when the shim cures.

5 For maximum output the working skins and their bedding shim can eadily be removed from their bolster and temporarily stored in holding jigs when, for example, gel coatings are being sprayed on or fibre packs are being inserted (or indeed both). These holding jigs can usefully incorporate heater cloths or nets to maintain background temperature whilst the production skin is out of the production bolster. In this way the loaded skin is prepared and ready at or near production temperatures.

6 The proposed process enables 'smart' tooling operations to be undertaken. Typically after resin has been injected into the mould a consolidating pressure can be introduced between bolster and skin to provide for a fractional squeeze the sealed resin impregnated cavity.

The exemplary embodiment refers to the use of a skin of conventional thermoset resins laminated with reinforcements as generally used in the GRP/components industry. However this skin, designed to fit a shaped "solid bolster could be made from a variety of materials , and as such also made in a different way from my example. The following are offered by way of example:

Thermoplastic sheet, vacuum formed;
Metal sheet, panel beaten to shape or pressed into shape for example hydraformed;
Metal shin, cast into shape;
Ceramic skin, pour moulded or pressed into shape;
Silicone or similar elastomeric matrix skin, cast, pressed or fabricated into shape;
Thermoset reinforced or un reinforced skin, pressure injected into shape;
Any suitable formable or mouldable material processed by whatever means into shape to form the mould skin.

The present invention provides for low cost tooling or mould construction by considering the possibilities arising from skin tooling rather than depending on existing solid conventional tooling build concepts.

Other features of the invention contrasting with existing processes include:
the provision of a process providing for reduction in mould material cost;
reduction in mould building labour cost;
faster mould production;
maintenance of high quality mould.part surface due to thin skin homgeneity.

The process also provides for a user of the process and moulds and tools produced by it in contrast to extsting systems:
quicker first off moulding;
multiple tooling faces without normal multiple costs;
mould face renewal at low cost;

less tooling capital outlay;
higher production voulmes with little or no increased capital expenditure;
greater capitalisation of tooling investment; and
low cost skin renewal.

CLAIMS

1 A process for the manufacture of tooling comprising the use of a thin skin mould supported in a bolster by way of an elastomeric shim over the entire under surface of the mould which shim is in turn supported on an in-fill in the bolster wherein the thin skin is of at least one of the following: vacuum formed thermoplastic sheet; metal sheet however formed; cast metal skin; ceramic skin however formed; silicone or similar elastomeric matrix skin however formed; thermoset reinforced or un-reinforced skin however formed.

2 A process as claimed in Claim 1 wherein the thin skin is of composite construction, that is to say of two or more layers, formed to receive the elastomeric shim.

3 A process for the manufacture of tooling characterised by the steps of:

1 forming on a surface of a master pattern member a skin layer by casting or laminating of plastics material; the skin layer during this stage having an inner face contacting the member and an exposed outer face;

2 depositing on the exposed face of the skin layer a calibration layer of substantially uniform thickness of a material such as wax; the calibration layer during this step having an inner face contacting the skin and an exposed outer face;

3 depositing on the exposed face of the calibration layer a bolster layer of a heat insulating material optionally including means whereby the bolster layer can be heated or cooled or providing for both heating and cooling relative to ambient temperature;

4 shrouding the exposed face of the bolster layer by way of a bolster frame so as to provide between the exposed face of the bolster layer and an inner face of the bolster frame a plenum;

5 filling the plenum with an aggregate material providing for thermal insulation between the bolster layer and the bolster frame;

6 separating the pattern with the skin layer retained thereon from the

assembled bolster frame, bolster layer and calibration layer;

7 removing the calibration layer to expose the inner face of the bolster layer;

8 provide a release means on the exposed inner surface of the bolster layer;

9 relocate the pattern with the skin layer retained thereon into the assembled bolster frame and bolster layer;

10 inject or otherwise locate in the volume left on removal of the calibration layer between the exposed face of the skin layer and the exposed inner surface of the bolster layer a plastics material to provide a locking shim reproducing the exposed face of the skin layer; and

11 separating the pattern from the remainder of the assembly when formation of the locking shim is complete;

12 removing the release means from the bolster layer;

13 locating the skin on the locking shim in the bolster to provide the tool comprising the skin layer releaseably mounted on the bolster layer by way of the locking shim and the bolster layer retained in the bolster frame.

4 A process as claimed in Claim 3 including the step of causing periphery of the skin layer to be sealed to a complementary region of the bolster layer to enable a pressure differential to be provided, such as by evacuation, to improve retention of skin layer on bolster layer.

5 A process as claimed in Claim 3 wherein the skin layer is retained in place on the bolster layer at least in part by the use of separable contact material such as 'Velcro' (RTM).

6 A process as claimed in any of preceding claims 3 to 5 wherein the skin layer is formed from a silicone based material.

7 An article of tooling manufactured by a process as claimed in any preceding claim when used in a production process.

8 An article of tooling as claimed in Claim 7 when used in conjunction with a further article of tooling also manufactured by a process as claimed in any of preceding claims 1 to 6.

9 An article of tooling as claimed in Claim 7 or 8 when used in conjunction with at least one further bolster member serving as a holding jig for the skin layer while the skin layer is released and outside the tool.

10 An article of tooling as claimed in Claim 9 wherein the or each furtehr bolster member is equipped with heating means to provide for heating of the skin when located on the furtehr bolster.

11 A component of plastics material manufactured by means of a tool manufactured by the process of Claims 1 to 6 or by an article of tooling as claimed in Claims 7 to 10.

12 A process as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Application No:	GB 9623587.4	**Examiner:**	J P Leighton
Claims searched:	1-12	**Date of search:**	18 February 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B5A(AA1, AA2, AA3, AB14, AM5X, ANX, AT14E, AT14G)

Int Cl (Ed.6): B29C(33/38, 39/26, 41/38, 43/36, 45/26)

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB1245724A	Maria-Edith Leowald	
A	GB0923321A	O J Gagne & B J Brown	
A	GB0900570A	Bristol Aeroplane Plastics Limited	
A	GB0738403A	N V Philips' Gloeilampenfabrieken	
A	EP0117985A2	A Pütz	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.